

Harpeth River

Watershed & Water Quality Model Training
February 25, 2021

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Training Objective

- Provide an overview of the contents of the modeling package
- Provide a general understanding of the modeling approach
- Provide a summary of data used in the models
- Introduce you to some of the tools
- Provide demonstration of how to run and review model results

Contents:

GIS – Model Coverages (Subbasins, Segmentation, Point Sources, Monitoring Stations, USGS Flow Gages)

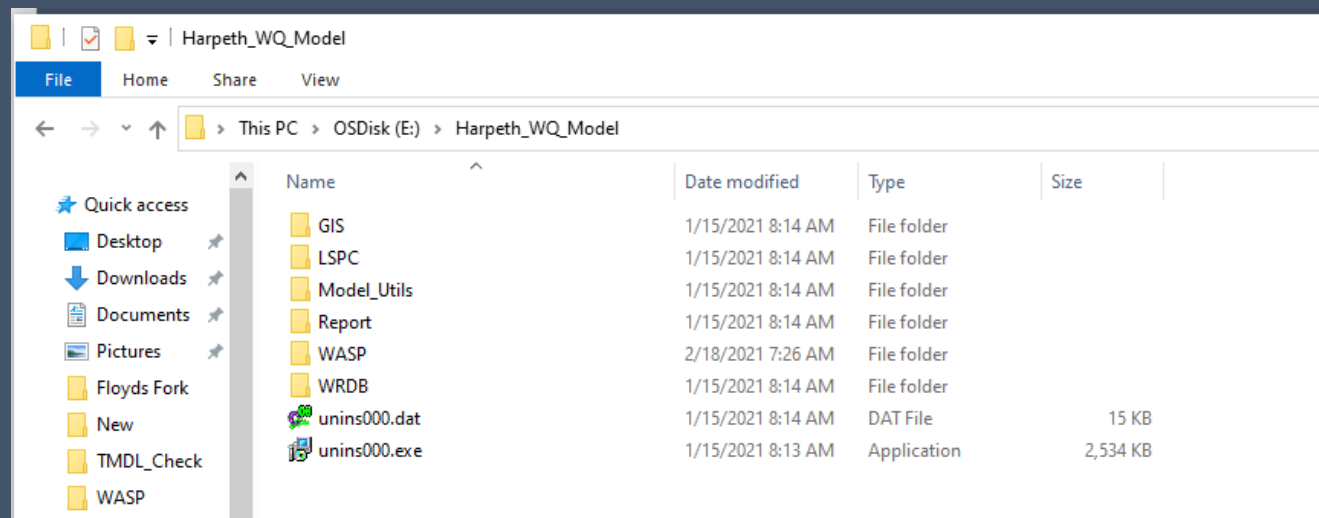
LSPC – LSPC Watershed Model, support database, input files, Weather files

Model_Utils – Spreadsheet tool to process LSPC Output for WRDB to go to WASP, WASP Segment meta data tool

Report – contains all the modeling documentation.

WASP – contains the WASP input file with all information queried, SOD restart file.

WRDB – Harpeth River Water Resources



Water Resources Database

WRDB

- Organized Harpeth Monitoring and Modeling Data
 - Ambient Monitoring Data
 - Mainstem Monitoring Stations
 - Tributary Monitoring Stations
 - Continuous Monitoring (Sondes)
 - Point Source Discharge Data and Characterization
 - Model Data
 - Meteorological Data
 - Processed Watershed Model Results for Water Quality Model

Harpeth WRDB Working Tables

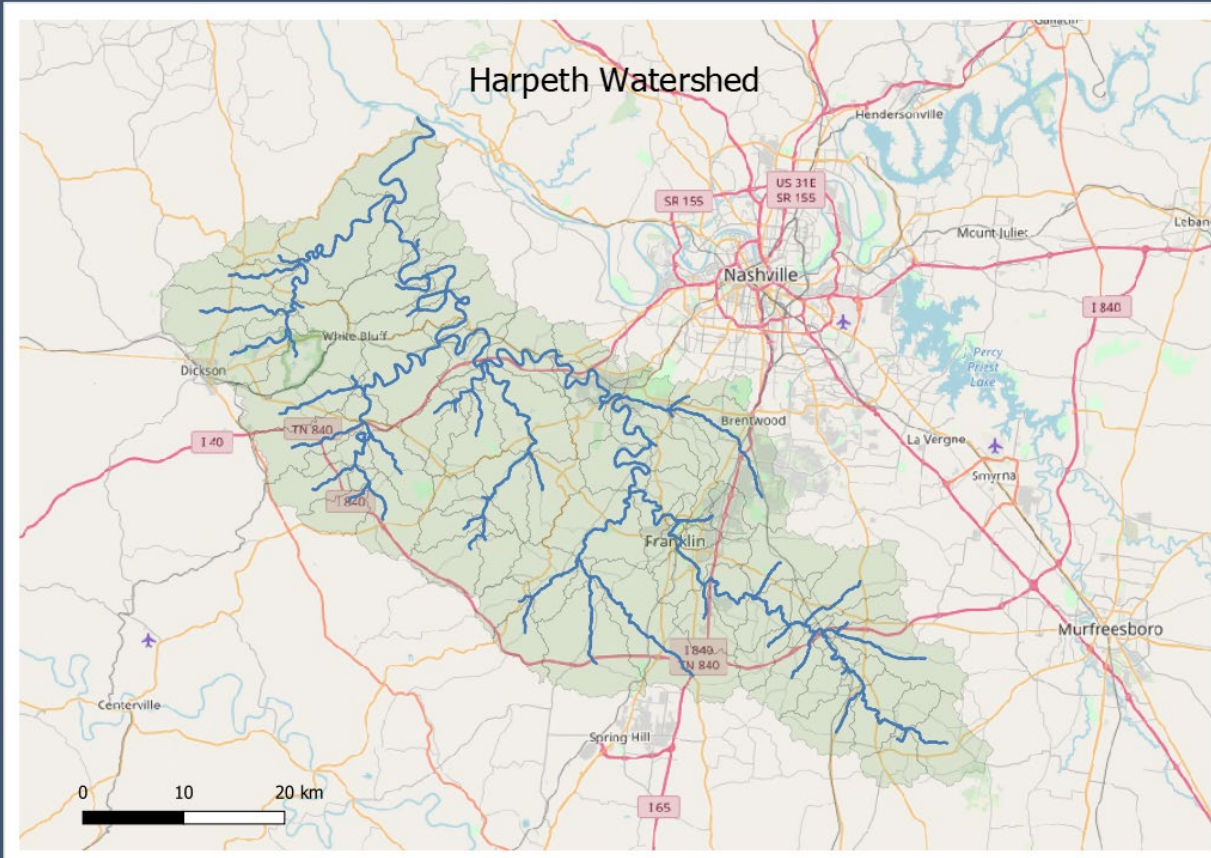
Open Working Table ? X

Tables to Display: (All Working Tables) Build Groups... Edit Table Info... Edit All Tbl Info...

Table Name	Description	Source
Calibration_Wq_Cont	Continous calibration data collected in Harpeth from 2012-2019 and processed by EPA	Hrpth_Combd_WQ_Data_2012_2019_AH_3_12_20.xlsx Hrpth_RsIts_table_Cor
Calibration_Wq_Grab	Calibration data collected in Harpeth from 2012-2019 and processed by EPA	Hrpth_Combd_WQ_Data_2012_2019_AH_3_12_20.xlsx Hrpth_RsIts_table_Gra
Hrpth_Dly_Flow	Daily flow averages for USGS gages in the Harpeth Watershed. Values in both CFS and CMS	NWIS, JD processed 2011-2018 uploaded on 4/6/20 Hrpth_Combd_WQData_
Lspc	Model run 3/27/20 NOPS (no point source) Franklin withdrawal data for 2019 is same as 2018	processed with Tim's tool ratios are NH3=0.0516, NO3O2=.676 OrgN=0.273;
Phyto_Boundary	Seeding the RO Segments	Built by AH 10/2019
Point_Source_Wastestream_Dataset	Generated by JD Rscripts based on the Default_Values_Hrpth_3_17_2020_AH.xlsx	Hrpth_PS_WASP_Result2020-04-21.csv
Qlspc	Simulated Flows from the LSPC Watershed Model	LSPC Current Condition Simulation
Weather_Data	Processed Weather data for LSPC & WASP from NLDAS and Airport Station	NLDAS and Airport
Wq_Obs_For_Wasp_Calib	Water Quality Monitoring Data for the Mainstem Harpeth used for Model Calibration	STORET and Stakeholders
Wq_Obs_Tribs_Wasp_Calib	Water Quality Monitoring Data for the Tributaries to Harpeth used for Model Calibration	STORET and Stakeholders

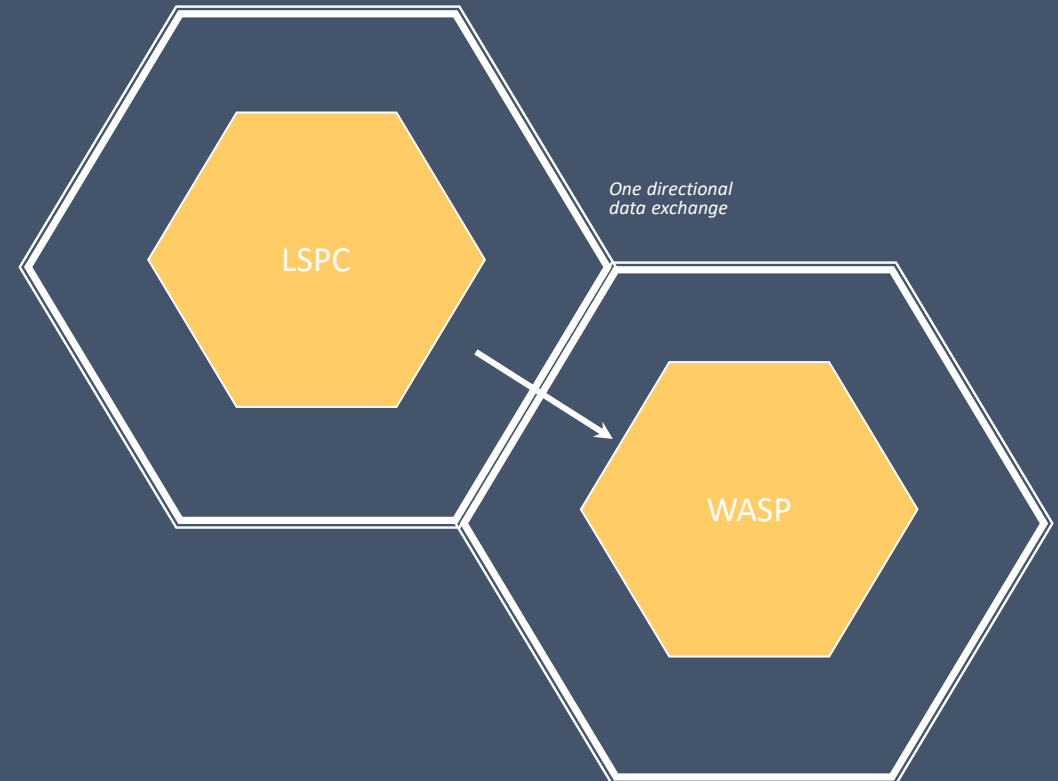
Harpeth WRDB Demonstration

Whole Watershed Approach



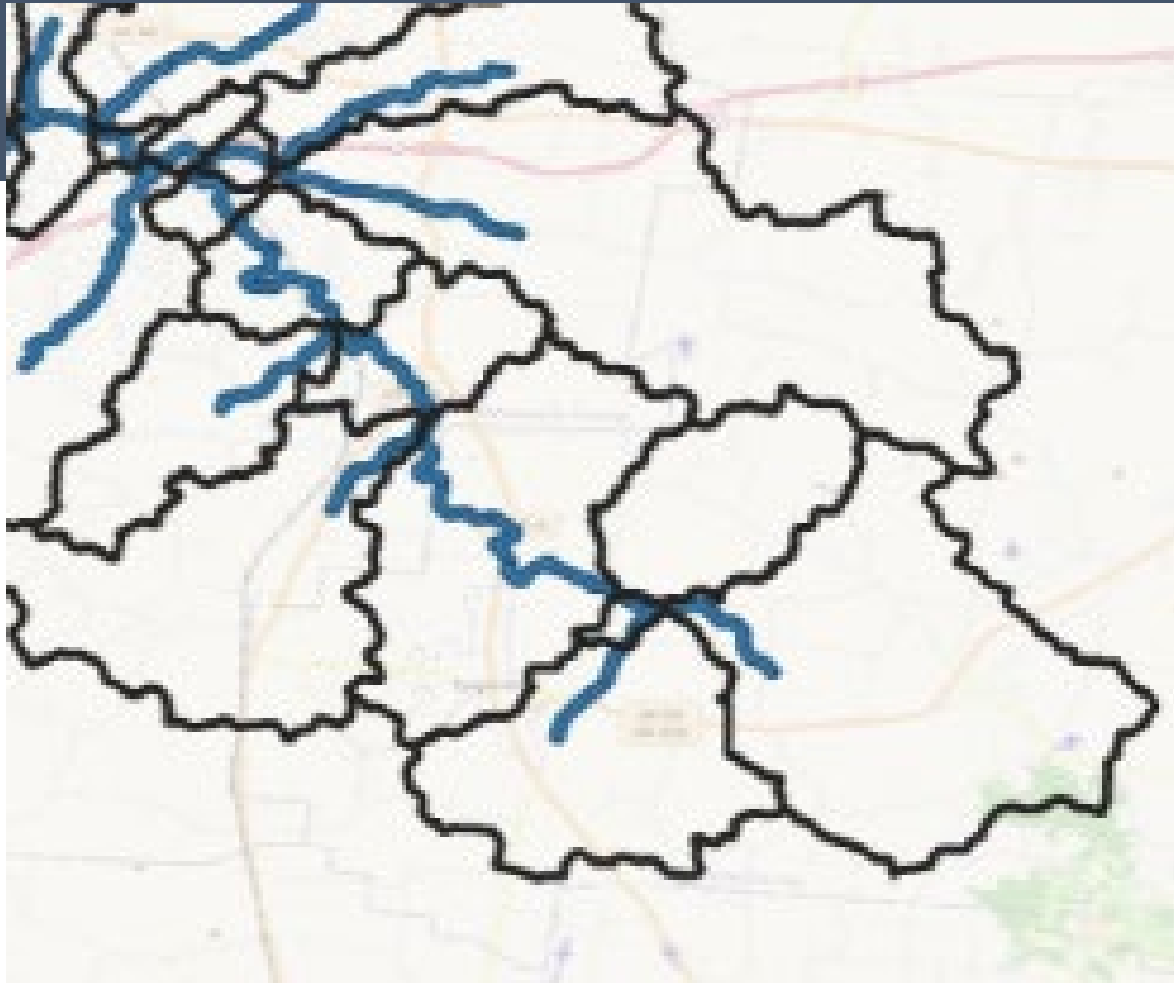
- Captures Both Point and Non-Point Loadings
- Allows for Source Assessment
- Management Scenarios
- Best Management Practices

- ▶ LSPC – Loading Simulation Program C++
 - Simulates watershed loadings delivered to the estuary
- ▶ WASP – Water Quality Analysis Simulation Program
 - Simulates the water quality response within the estuary



- LSPC – Watershed Model
 - Driven by Hourly Meteorological Conditions
 - Provide Daily Average Flows and Loads
 - Accounts for Non-Point Source Pollutant Contribution
- WASP – Water Quality Model
 - Integrates Flows and Loads
 - Watershed Model
 - Point Source Dischargers
 - Water Withdrawals
 - Predicts Water Quality Conditions

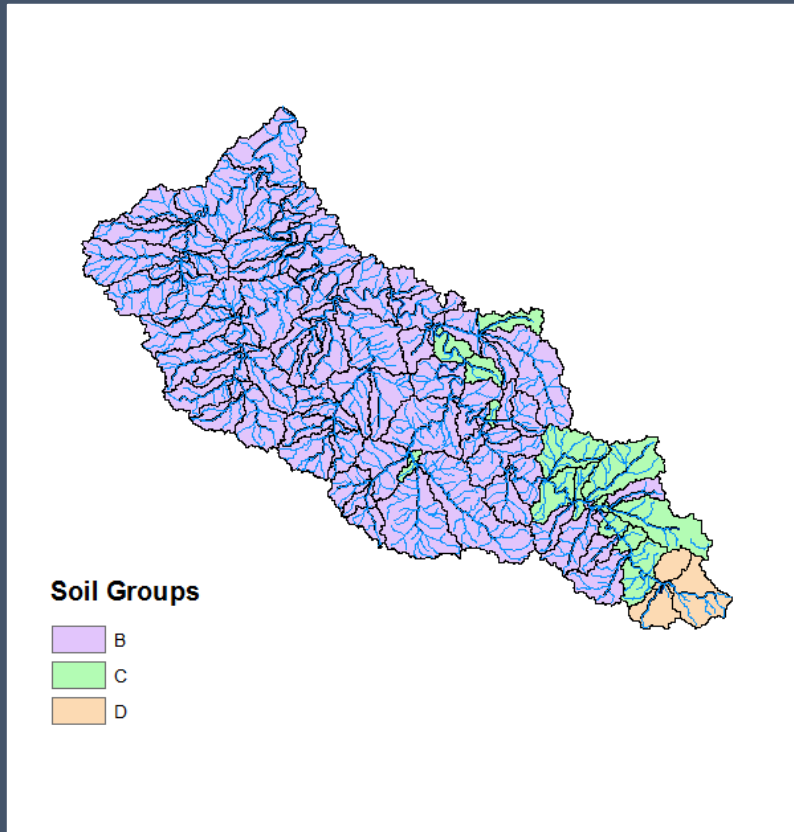
- Time Domain for Model Framework
 - LSPC
 - 2011 through 2019
 - 2011 is a Spin Up Year
 - WASP
 - 2021 through 2019
- Continuous Simulation
 - Accounts for variable meteorological conditions
 - Seasonal Variation
 - Allows for consideration of frequencies, magnitude and duration of water quality conditions



Overview of Models

- Watershed Model
 - Delineated into 101 subbasins
 - Simulates
 - Surface Runoff
 - Interflow
 - Groundwater
 - Pollutant Runoff
 - Erosion

Watershed Model



Soil Groups

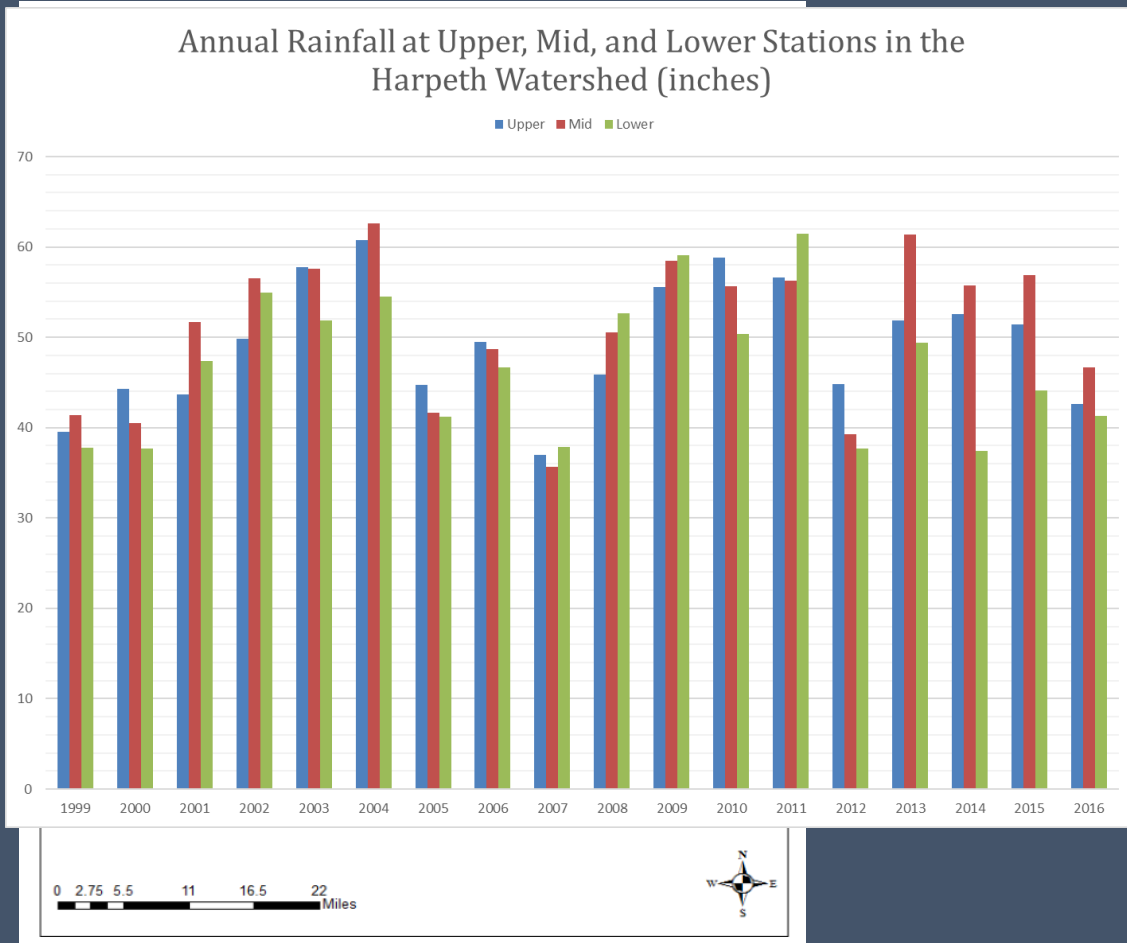
- Each Subbasin is assigned the predominant soil type
 - Used for Infiltration calculation

DELUNAME	Sum of AREA (Acres)
Water	1344
Developed, Low Intensity, Pervious	49573
Developed, Low Intensity, Impervious	9108
Developed, Medium Intensity, Pervious	2819
Developed, Medium Intensity, Impervious	4438
Developed, High Intensity, Pervious	242
Developed, High Intensity, Impervious	1444
Barren	562
Forest	327084
Pasture	134280
Crop	12324
Wetland	7262
All Other Impervious	101
Total	550581

Landuse Classification

- 2016 National Land Cover
 - Aggregated to 14 Landuse Groups
- Land Cover Controls
 - Pollutant Contribution in Runoff
 - Runoff Volume
 - Pervious vs. Impervious

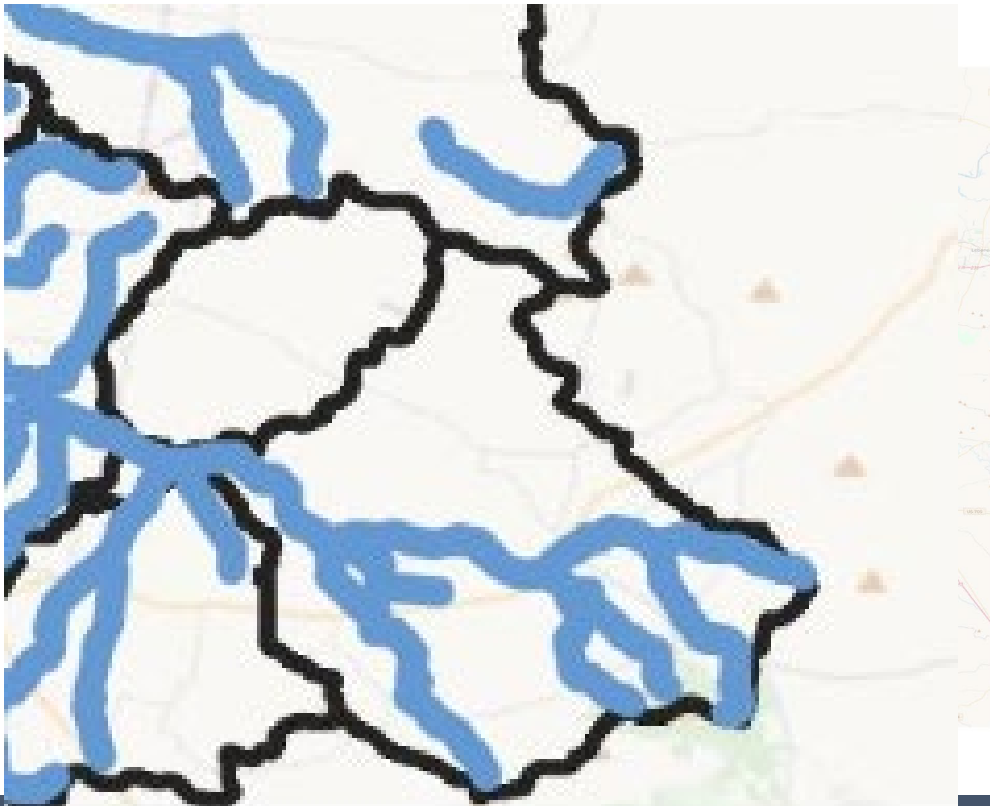
Watershed Model



Weather Data

- Hourly Meteorological Data
 - Rainfall
 - Potential Evaporation
 - Air Temperature
 - Dew Point
 - Cloud Cover
 - Solar Radiation
 - Wind Speed

Water Quality Model



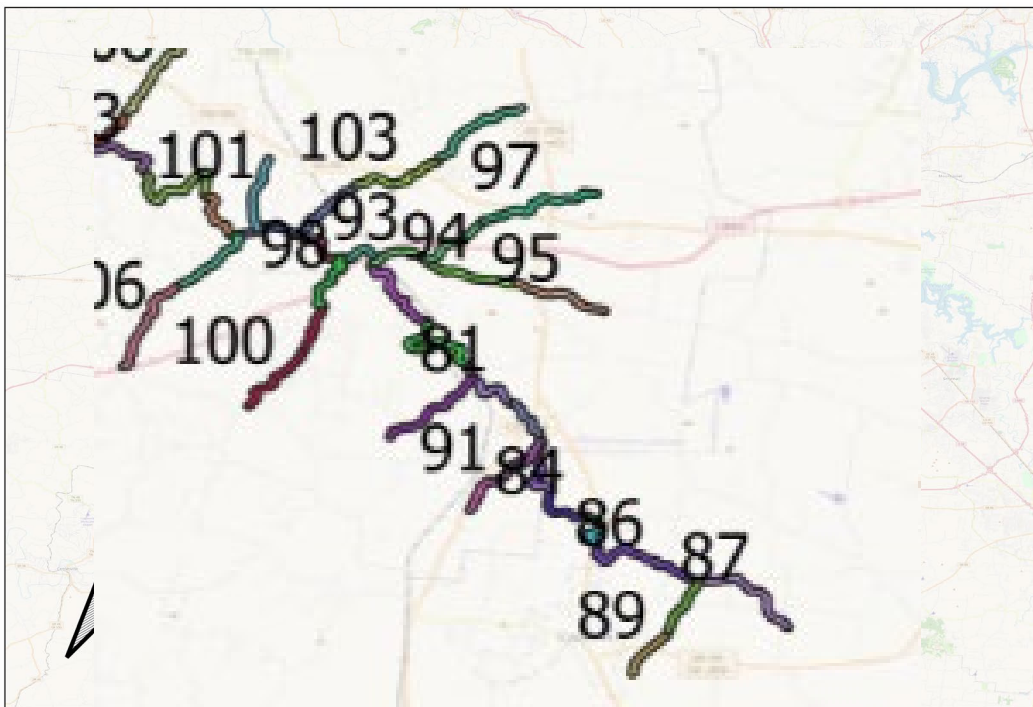
Water Quality Model Segmentation

- National Hydrography Dataset
 - Provides
 - Average Conditions for Stream Channel
 - Length, Slope, Roughness
 - Average Depth, Width, Velocity

Water Quality Model

Segmentation

Harpeth River Water Quality Model Segmentation

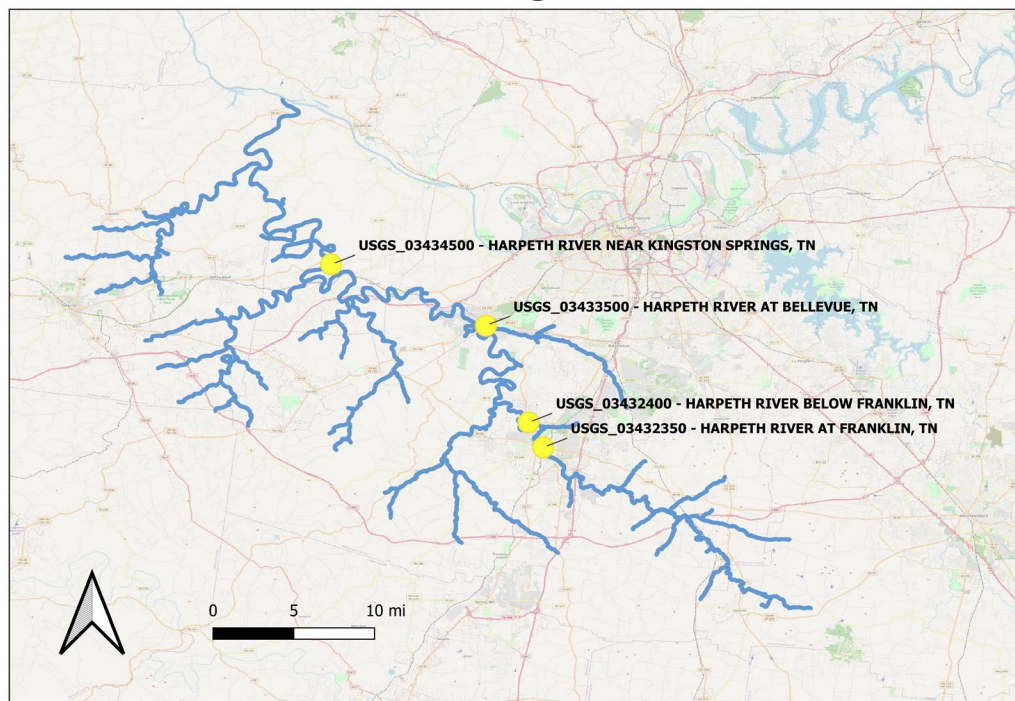


- Harpeth River and Tributaries
 - 185 Segments
 - Segment to Reach All Treatment Plants
 - Covers most stream segments Stream Order 2 or Higher

Measured Data

USGS Flow Gages

USGS Flow Gage Locations

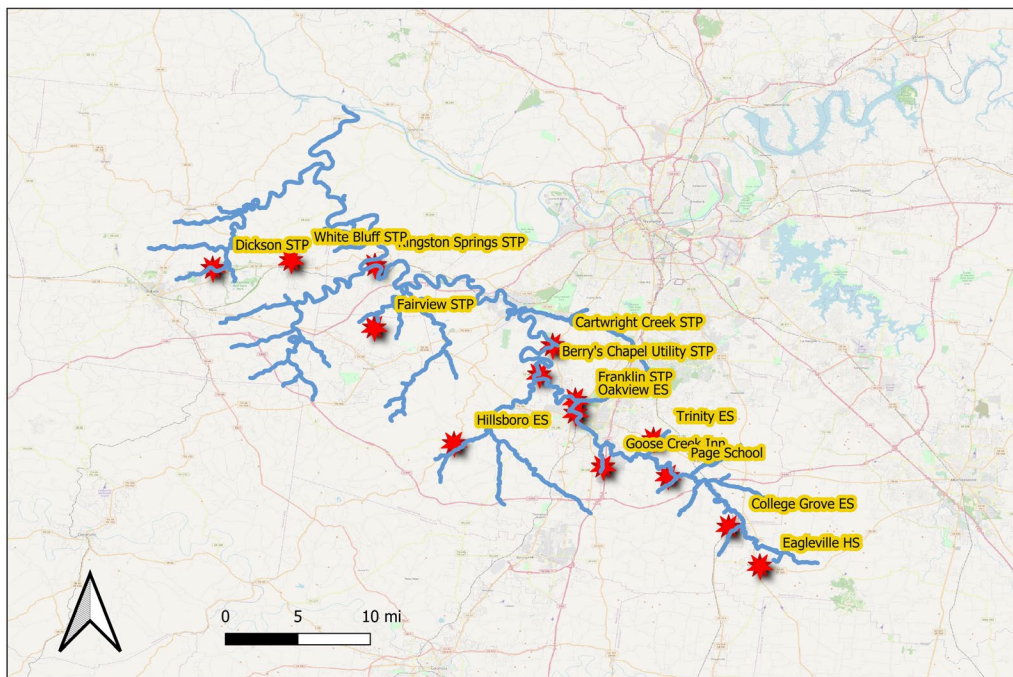


Station	Station Name	First Date	Last Date	No. Obs
USGS_03432350	HARPETH RIVER AT FRANKLIN, TN	01/01/2011 00:00	12/31/2018 00:00	5,186
USGS_03432390	SPENCER CREEK NEAR FRANKLIN, TN	01/25/2012 00:00	01/26/2013 00:00	368
USGS_03432400	HARPETH RIVER BELOW FRANKLIN, TN	01/01/2011 00:00	12/31/2018 00:00	2,920
USGS_03433500	HARPETH RIVER AT BELLEVUE, TN	03/29/2012 00:00	12/31/2018 00:00	2,469
USGS_03433640	COPPERAS BRANCH NEAR KINGFIELD, TN	01/01/2011 00:00	08/06/2012 00:00	584
USGS_03434500	HARPETH RIVER NEAR KINGSTON SPRINGS, TN	03/29/2012 00:00	12/31/2018 00:00	2,469

Point Sources

Discharger Summary

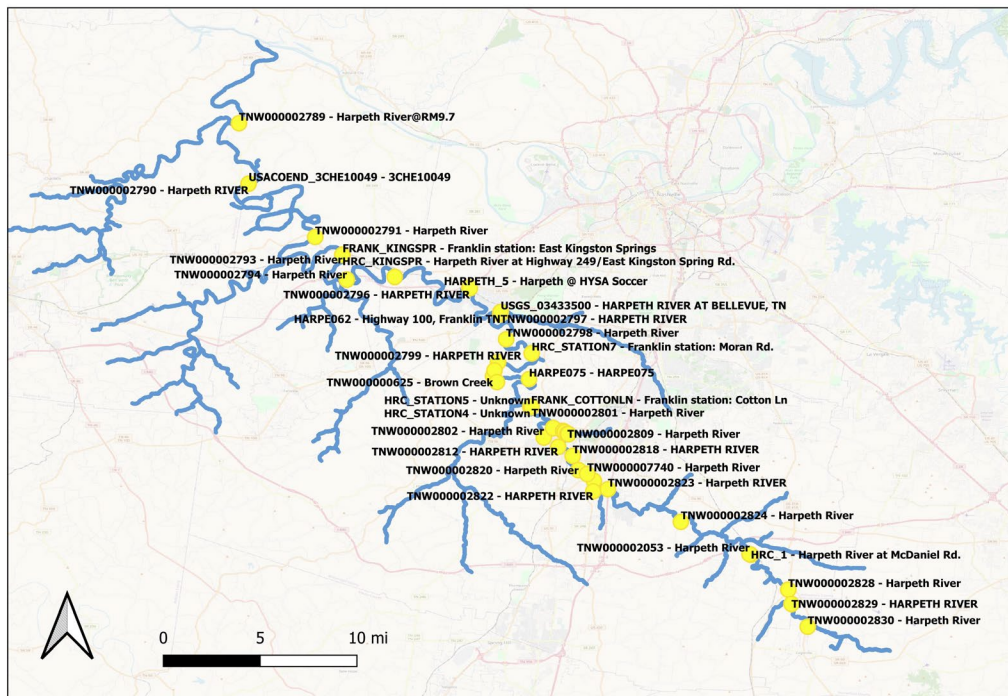
Point Source Dischargers



Station	Station Name	First Date	Last Date	No. Obs
TN0020460	White Bluff STP	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0027278	Cartwright Creek STP	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0028827	Franklin STP	01/01/2011 00:00	12/31/2019 00:00	38,298
TN0029718	Berry's Chapel Utility STP	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0057789	Eagleville HS	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0057827	Hillsboro ES	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0057835	Page School	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0059790	Kingston Springs STP	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0060216	Goose Creek Inn	01/01/2011 00:00	12/31/2019 00:00	16,107
TN0062332	Fairview STP	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0064297	Trinity ES	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0066958	Dickson STP	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0067164	College Grove ES	01/01/2011 00:00	12/31/2019 00:00	2,808
TN0067873	Oakview ES	01/01/2011 00:00	12/31/2019 00:00	2,808

Monitoring Data

Harpeth Mainstem Monitoring Stations



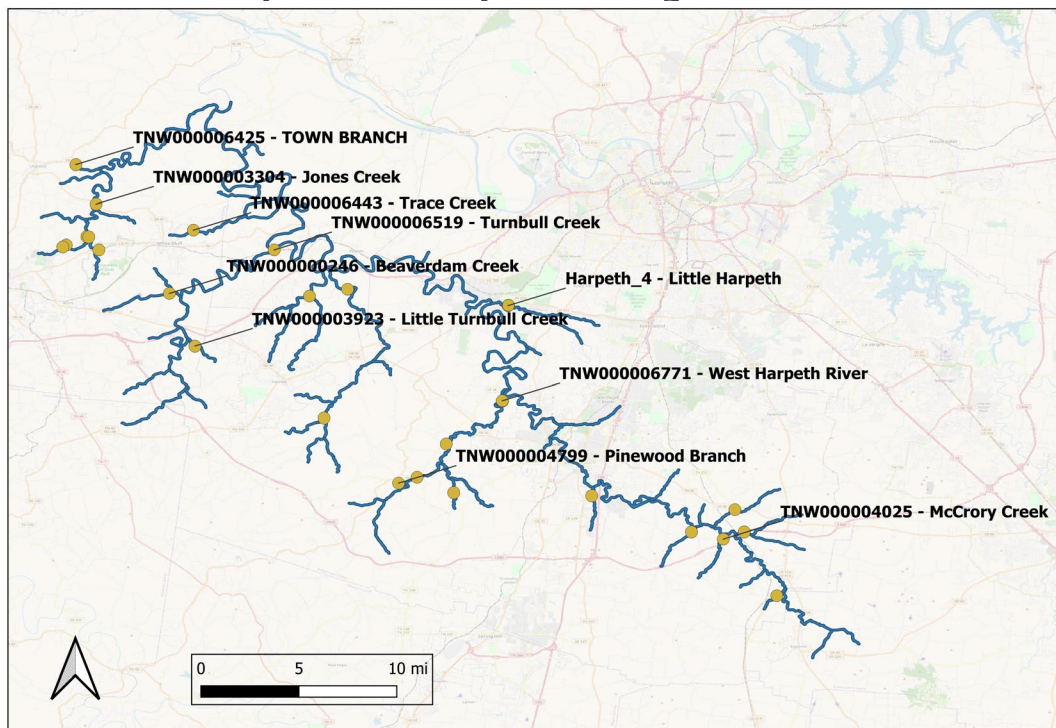
Mainstem

- 120 Monitoring Stations
- Variability in
 - Parameters Measured
 - Frequency/Number of Measurements

32 Stations

Monitoring Data

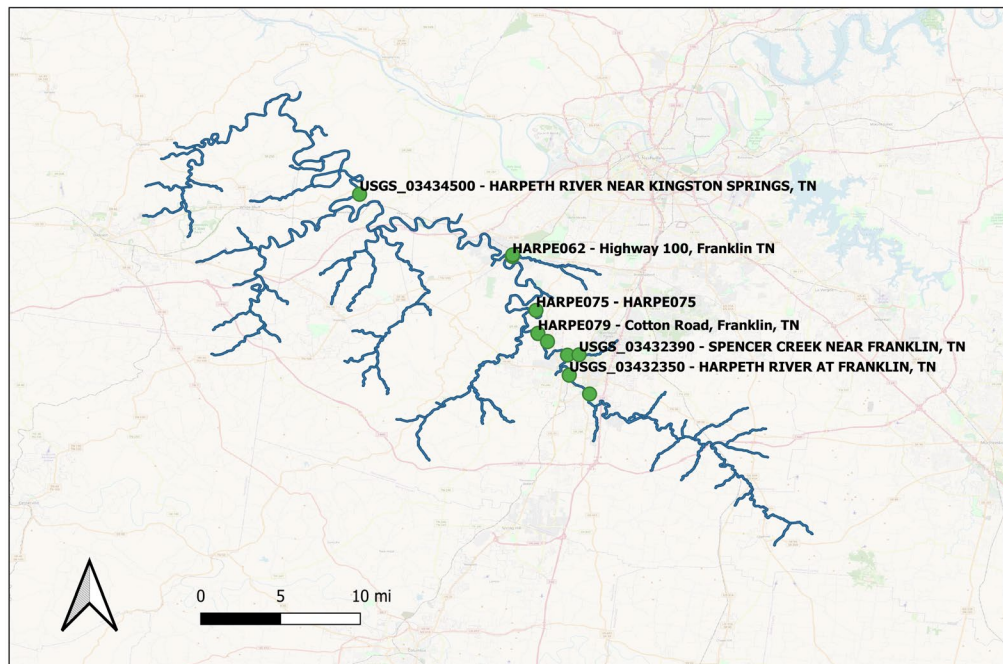
Harpeth Tributary Monitoring Stations



Station	Station Name	First Date	Last Date	No. Obs
FRANK_DELRIO	Franklin station: Del Rio	07/25/2017 07:55	10/30/2018 07:25	264
HARPETH_4	Little Harpeth	03/07/2018 09:07	10/31/2018 07:55	121
HARPETH_SITE_9	Dickson station: Harpeth Site #9	07/11/2017 10:15	10/23/2018 08:40	285
HRC_4	Little Harpeth at Edwin Warner	05/02/2018 10:44	10/31/2018 11:16	193
SOD5	Harpeth DS West Harpeth	09/27/2017 13:25	09/27/2017 13:25	2
SOD7	Little Harpeth	09/26/2017 14:30	09/26/2017 14:30	2
SOD9	South Harpeth	09/28/2017 12:45	09/28/2017 12:45	2
TNW000000050	Arrington Creek	08/08/2012 10:30	06/07/2017 11:45	142
TNW000000246	Beaverdam Creek	01/17/2012 09:05	06/27/2017 09:37	140
TNW000001452	Creech Hollow (Unnamed Creek In Hollow)	07/26/2016 11:48	06/27/2017 09:13	24
TNW000002425	FIVEMILE CREEK	01/04/2012 15:09	03/03/2017 10:15	65
TNW000003304	Jones Creek	07/26/2016 09:45	06/20/2017 08:45	62
TNW000003306	Jones Creek	01/04/2012 10:25	06/20/2017 09:25	165
TNW000003508	Leatherwood Creek	01/03/2012 11:15	06/08/2017 09:35	67
TNW000003576	Little Harpeth RIVER	01/04/2012 08:30	06/27/2012 08:20	63
TNW000003923	Little Turnbull Creek	02/22/2012 13:45	06/27/2017 10:09	64
TNW000004025	McCrory Creek	07/17/2012 11:40	06/07/2017 10:55	186
TNW000004322	MURFREES FORK	07/17/2012 09:20	07/21/2016 12:24	112
		07/19/2012	09/11/2018	

Continuous Monitor Locations

Dissolved Oxygen and Water Temperature Data



Sonde Locations

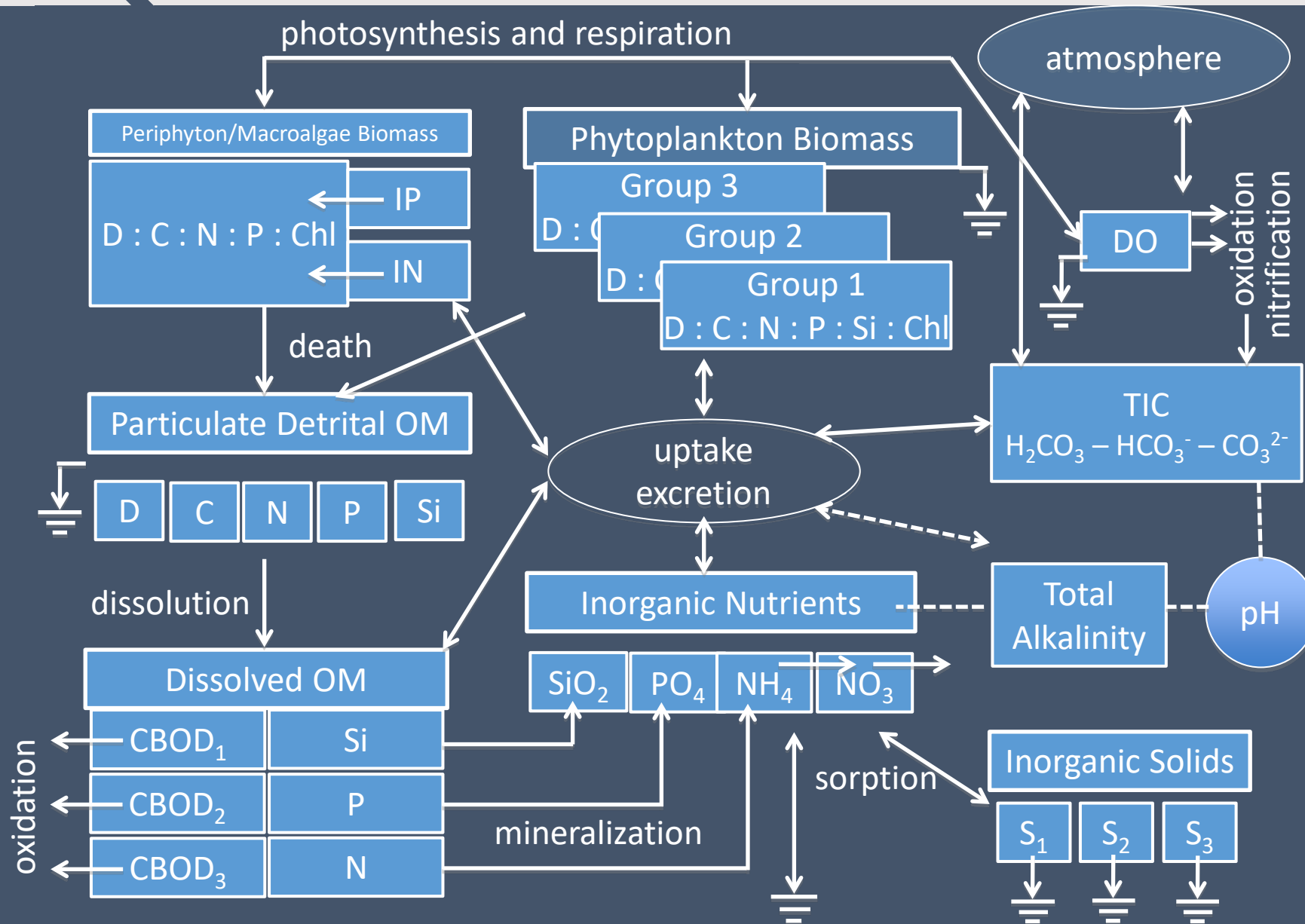
Station	Station Name	First Date	Last Date	No. Obs
HARPE062	Highway 100, Franklin TN	09/17/2013 14:00	10/15/2013 16:00	5,429
HARPE075	HARPE075	09/12/2013 10:30	10/15/2013 14:30	5,885
HARPE079	Cotton Road, Franklin, TN	09/11/2013 12:00	10/15/2013 12:30	8,125
HARPE085	Franklin Road, Franklin TN	09/10/2013 12:30	10/15/2013 10:30	8,340
USGS_0343233905	Harpeth River At Mile 90.5 Near Franklin, Tn	09/17/2015 06:00	11/06/2019 18:00	19,948
USGS_03432350	HARPETH RIVER AT FRANKLIN, TN	08/26/2014 12:00	10/29/2014 18:00	1,000
USGS_03432390	SPENCER CREEK NEAR FRANKLIN, TN	01/26/2012 00:00	10/01/2012 00:00	1,994
USGS_034324146	Harpeth River At Mile 81.33 Nr Berrys Chapel, Tn	10/21/2016 06:00	10/29/2019 12:00	12,677
USGS_03433500	HARPETH RIVER AT BELLEVUE, TN	08/16/2016 00:00	12/31/2019 18:00	17,990
USGS_03434500	HARPETH RIVER NEAR KINGSTON SPRINGS, TN	06/11/2018 12:00	12/31/2019 18:00	6,611

Next Steps

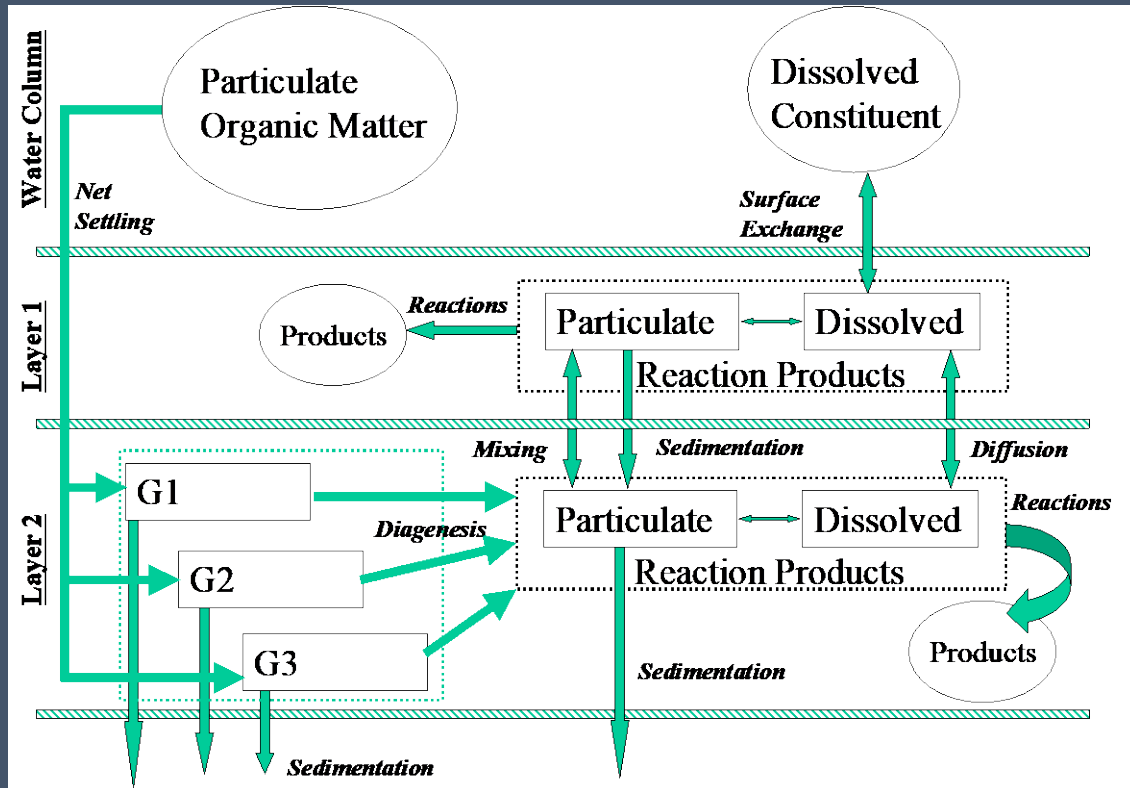
- Try to use WRDB download from www.wrdb.com
- Execute the LSPC Model
 - Plot Model Results

Harpeth River Water Quality Model

WASP Water Quality Model



- Sediment Diagenesis Module
 - Sediment Oxygen Demand
 - Ammonia Flux
 - Phosphorus Flux



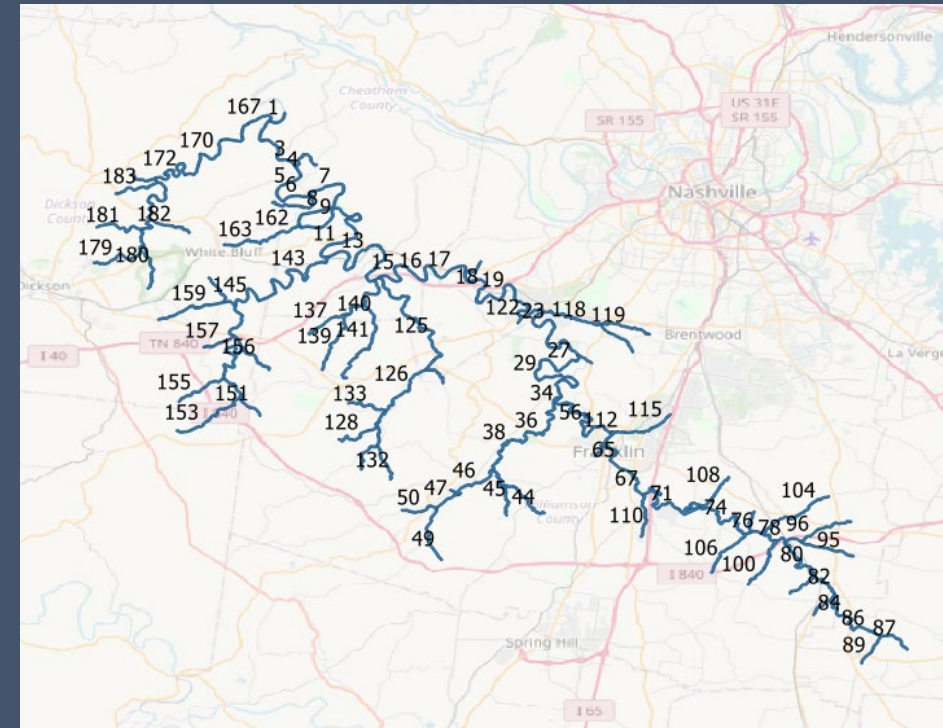
- General Water Quality
 - salinity, pH, solids, temperature
- Nutrient Enrichment
- Dissolved Oxygen Depletion
- Algal Production
 - Phytoplankton (lakes, reservoirs, estuaries)
 - Periphyton (streams)
 - Macro Algae

- Ammonia (NH₃ / NH₄⁺)
- Nitrate (NO₂⁻ + NO₃⁻)
- Phosphate
(H₂PO₄ / HPO₄⁻ / PO₄²⁻)
- Silicate (SiO₄)
- Dissolved Oxygen
- Salinity
- Alkalinity
- TIC
- (pH)
- Solids (1 class)
- Water Temperature
- Phytoplankton (1 class)
 - Biomass D:C:N:P:Si:Chl
- Periphyton/Macroalgae
 - Biomass D:C:Chl
 - Nitrogen
 - Phosphorus
- Particulate Detritus
 - POM
 - POC
 - PON
 - POP
 - POSi
- Dissolved Organic Matter
 - CBOD (3 classes)
 - DON
 - DOP
 - DOSi

- Rates, Constants, and Kinetics
 - https://cfpub.epa.gov/si/si_public_record_report.cfm?Lab=CEMM&dirEntryId=348267
 - Steve Chapra
 - [Surface Water Quality Modeling](#)
- James Martin
 - [Hydrodynamics and Transport for Water Quality Modeling](#)
- Thomann and Mueller
 - [Principles of Surface Water: Quality Modeling and Control](#)

Harpeth River Model Network

- WASP Network
 - 185 Segments
 - Kinematic Wave Transport
 - No Sediment Segments
 - 1 Sediment Diagenesis Compartment per Water Column Segment
 - 113 Flow and Concentration Boundaries
 - Updated Daily



LSPC Linkage

WASP Demonstration

Calibration